Journal of Environmental Health Science and Engineering (2021) 19:173–179
https://doi.org/10.1007/s40201-020-00591-9

RESEARCH ARTICLE

Municipal solid waste management during COVID-19 pandemic: a comparison between the current activities and guidelines

Javad Torkashvand[1,2,3] · Ahmad Jonidi Jafari[1,2] · Kazem Godini[4] · Zahra Kazemi[2] · Zohre Kazemi[2] · Mahdi Farzadkia[1,2]

Received: 19 September 2020 / Accepted: 7 December 2020 / Published online: 12 January 2021

Abstract

The COVID-19 pandemic has affected everyone's lifestyle and this has resulted in a change in the quantity and composition of municipal solid wastes. Moreover, the post-pandemic waste management is very important as a bad management may lead to the more spread of the disease. The objective of this study was to evaluate the application of guidelines presented for the era of the COVID-19 pandemic in proper solid waste management. To this end, the data were collected by using interviews and field researches and then the obtained data were compared with the international guidelines presented by international organizations. By investigating the municipal waste management during this pandemic and its changes compared to pre-COVID-19, coordination of the plans with the guidelines was investigated. The activities of storage, collection, transportation, recycling, final landfill, as well as the observation of the health instructions by staff and informal sections were assessed in the current research. Although the results showed that the situation was satisfactory in the sections like health and safety of waste management operators due to the existence of protocols and general educations, the waste management plans have not been changed much from before the epidemic of the Coronavirus. The absence of a national policy and plan for waste management in the era of a pandemic and ignoring the guidelines developed by other countries and organizations were observable. Therefore, the codification of new policies for municipal waste management during an epidemic is necessary.

Keywords Municipal solid waste · Waste management · COVID-19 · Iran

Introduction

This coronavirus disease (COVID-19) was discovered for the first time in Wuhan, China, in December 2019. This virus spreads mainly from person-to-person through respiratory droplets and close contact [1–3]. COVID-19 became a global pandemic and has influenced human life. Globally, on 2 November 2020, there were 46,403,652 confirmed cases of COVID-19, including 1,198,569 deaths, reported by the World Health Organization (WHO) [4]. Moreover, in Iran, up to the mentioned date above, 628,780 cases of COVID-19 as well as 35,738 deaths were reported [5].

The COVID-19 global pandemic caused a disruption in the routine normal life in the Iranian people at first, however, with the development of sanitation and health protocols, and changes in population's lifestyles, most of the normal activities have resumed after a few months. The spread of COVID-19 and its changes in people's lifestyle have impacted upon the quantity and composition of municipal solid wastes [1, 6]. An increase in the quantity of wastes has been seen because the possible risk of spreading the virus in recycling centers [7]. Furthermore, since people use more disposable products such as face masks and gloves, many of them are littered in every part of cities [6, 8]. It makes it necessary to take into account a sustainable municipal waste management [1]. Hence, several attempts have been made to discover solutions to decrease the chance of the transmission of COVID-19 through municipal solid wastes [9–11]. However, many countries lack the utilization proper policies and plans for municipal solid waste

✉ Mahdi Farzadkia
farzadkia.m@iums.ac.ir; Mahdifarzadkia@gmail.com

1 Research Center for Environmental Health Technology, Iran University of Medical Sciences, Tehran, Iran

2 Department of Environmental Health Engineering, School of Public Health, Iran University of Medical Sciences, Tehran, IR, Iran

3 Student Research Committee, Faculty of Public Health Branch, Iran University of Medical Sciences, Tehran, Iran

4 Environmental Health Research Center, Research Institute for Health Development, Kurdistan University of Medical Sciences, Sanandaj, Iran

management during the epidemic; this may increase the spread of the disease. Since the COVID-19 pandemic has led to a change in lifestyle and behaviours of humans, it is highly likely that the quality and quantity, as well as the pollution potential to the infection agent are different from those before the pandemic. Therefore, it is required to manage solid wastes according to new conditions. The current research aimed to investigate and compare the conformity of solid waste management with the guidelines presented for the era of the coronavirus.

Method

This study was conducted using collecting information of waste management in two cities of Iran in the era of COVID-19 Pandemic (city A and city B) epidemic. The both cities are located in the northern part of the country and are the capital of the provinces which have a special organization for solid waste management in their municipalities. The data were collected by using interviews through the executive part of solid waste management and field researches of storage, collection and transportation. The municipal solid waste management activities were compared to guidelines for the era of COVID-19 Pandemic [12–14]. After the collection of the data, according to the obtained information, changes in municipal solid waste management in the era of COVID-19 epidemic for 4 months (March to July 2020) to the before the era of COVID-19 for 8 months (August until February 2019) in the fields of staff health, storage, and collection and transportation were investigated and compared with existing guidelines.

Results and discussions

It should be noted that the production rates of personal protective equipment (PPE) like disposable masks and gloves have increased considerably since the era of COVID-19 epidemic in Iran: Face mask (55 times), gloves (2.5 times), face shield (1000 times), medical gown (860 times) epidemic [15]. Therefore, it is expected that the use of this equipment has led to a change in the composition of municipal solid waste, compared to the pre-COVID19 period. Therefore, it is highly expected that the quantity and components the municipal solid waste have dramatically changed. Nevertheless, in the municipal solid waste management services section, there has been no difference in the frequency of services and the level of activity of the responsible organizations before and during the epidemy (Table 1). However, during the COVID-19 epidemic, the solid waste management system has equipped its employees with PPE to prevent them from the disease.

The above information can be compared with the guidelines provided for solid waste management during the COVID-19 epidemic, as indicated in Table 2. This comparison showed that in the field of personnel health, the protocols proposed by national institutions are properly executed, but in the areas such as trucks and collection operations the guidelines provided in Table 2 in waste management system of the surveyed cities are not executed.

Nevertheless, the municipal solid waste management system has put efforts like employees to PPE for waste management improvements during the epidemic of COVID-19; it should be noted that all the national guidelines mentioned in Table 3 have not observed.

Table 1 A survey on waste management in the cities without change during and before the covid-19 pandemic

Type of service or management equipment	Report	
	City A	City B
Trucks	Number of the municipal waste collecting trucks before the epidemic of the Coronavirus was 83 per month on average for city A and, during the epidemic, it has been 86, which is not a noticeable change	In city B, before and during the epidemic of COVID-19 the number of the trucks remained 120 and unchanged.
Activity duration of each truck	The duration of municipal waste collection for each truck before and during the epidemic of the Coronavirus was nearly 8 h in day.	In city B, the duration of the collection before and during the epidemic was around 220 h in month.
Container	Number of the solid waste storage containers in the streets and alleys curbside was 4400.	The number of the active containers before and during the epidemic was 1100.
Dustmen	During a one-year (8 months before and during 4 months of the Corona epidemic), the number of the dustmen was 480, who were at work 8 h a day.	The number of the dustmen was 1023 who daily working 8 h without change during the epidemic.
Street sweepers	Before and during the pandemic 6–12 street sweepers were used (8 h for each sweeper).	Before and during the pandemic 5 street sweepers were used (8 h for each sweeper).
Final disposal	Municipal solid wastes were landfilled after separating the recyclable components. Incinerators were not utilized for the disposal of municipal waste and there was no change in the landfill conditions.	19.8% of the municipal solid wastes were ultimately composted and the rest of the wastes were landfilled after separating the recyclable components.

Table 2 Guidelines for waste management in covid-19 pandemic

Waste service	Guideline/Suggestion	Ref.
Vehicles and collection operations	✓ Social distancing in workplace Handwashing and hand disinfectionDisinfection of vehicles in case of the use of suspected person or transmission to parking for 72 h	[13]
	✓ Protection of the respiratory system in workplace	
	✓ Opening cab windows	
	✓ Social distancing	[14]
	✓ Use of PPE	
	✓ Quick replacement of PPE in case of rupture or damage in them	
	✓ Handwashing and hand disinfection	
	✓ Density reduction of staff in workplace	
	✓ Access to water and soap and disinfectant in workplace	
Bulky waste collections	✓ Use of face mask and PPE	[13]
Mobile plant	✓ Use of alcohol, water and soap in cabs	[13]
	✓ Regular disinfection, particularly after every shiftwork	
	✓ Disinfection of vehicles in case of the use of suspected person or transmission to parking for 72 h	
	✓ Social distancing in workplace	[14]
	✓ Density reduction of staff in workplace	
MRFs and recycling plants	✓ Minimizing face-to-face contacts	[13]
	✓ Social distancing by adjusting work stations	
	✓ Density reduction through managing entry and exit of workers	
	✓ Social distancing	[14]
	✓ Density reduction through managing entry and exit of workers	
infection prevention and control for suspected or confirmed coronavirus cases self-isolating at home	✓ Use of separate waste bags for face masks and facial tissues of the patients	(https://www.ecdc.europa.eu/en/publications-data/infection-prevention-control-household-management-covid-19)
	✓ Use of second bag near door for face masks and facial tissues	
	✓ Being sure of closed transportable bags	
	✓ Observations of health instructions like washing and disinfection of hands after transporting bags	
Health and safety of waste management operators	✓ Management of staff density through social distancing and minimizing the minimum individuals in each point	(https://osha.europa.eu/en/highlights/covid-19-guidance-workplace)
	✓ Regular use of PPE	
	✓ Quick replacement of PPE in case of rupture or damage in them in workplace	
	✓ Providing special working conditions for vulnerable people like the elderly	
	✓ Increasing the level of health instruction level like PPE use and density reduction of staff	[12]
	✓ Avoidance of contact with bin or bags without wearing a glove	
	✓ Lack of contact drivers and collectors with residents	

Table 3 National guidelines for solid waste management during the corona pandemic [16]

Item	guidelines
collection operations	✓ Social distancing ✓ Reduction of working hours and staff numbers in each working shift ✓ Lack of intervention of driver in collection stages ✓ Self-declaration of disease symptoms by staff ✓ Daily assessment of disease symptoms in staff ✓ Attention to vulnerable staff like the elderly or patients with high blood pressure ✓ Use of PPE ✓ Supply of water, soap and disinfectants ✓ Handwashing and hand disinfection
Equipment	✓ Use of covered truck for transportation ✓ Washing and disinfection of trucks after each working shift ✓ Use of covered bins ✓ Daily washing and disinfection of all bins and equipment ✓ Daily disinfection of parking
Other guidance	✓ Prevention of waste picker activities ✓ Waste management of reservoirs near health care centers as medical waste ✓ Reception of COVID-19 patients with the wastes of health cares through special machinery ✓ Separate landfilling of all normal and health care wastes of health care centers accepting the patients and use of daily soil cover

Many studies have attempted to investigate different aspects of waste management during the Corona epidemic in the community. This disease has affected municipal and health-care waste management in different ways. One of the important reasons having impact on the waste management during the epidemic is the variation of the quantity and the quality of the waste due to the spread of COVID-19. Behavioural changes in people causes changes in the combination of the waste coming from consumption shifts and; it can change the situation in a way that exposes waste pickers and other informal workers to hazardous conditions [6]. Furthermore, a phenomenon happening during the COVID-19 epidemic is an increase in using single-use products such as face masks that has resulted in the growth of these products in the municipal waste combination and littered wastes observed in the beaches. [6, 8]. These conditions in this study were seen as increased use of single-use face masks and, in turn, increased littering of them in the studies pavements. Also, another change in municipal solid waste combination is the increase of online shopping and foodstuffs packaged by citizens during the epidemic, which has increased the volume of inorganic matters in municipal solid waste [7]. Therefore, during the emergence of COVID-19, due to the changes in people's lifestyles, like masking, home quarantines and online shopping, it is expected to see changes in the combinations of municipal solid wastes. For instance, Rhee has stated that the capacity of treatment facilities in solid waste management must be scaled up [10]. However, in the waste management of the two cities studied in this research, no purposeful changes were observed to control the new conditions. Poor waste management, however, can lead to the spread of the Coronavirus, one of the factors of which is the possibility of contamination of waste products produced in city, especially at the homes of suspected or infected people, because research has shown that this virus survives 24 h on cardboard and 2 to 3 days on plastic and stainless steel [17].

Solid waste management in the conditions brought up by the Corona epidemic needs fundamental changes in reacting to the variations in the composition and the quantity of municipal waste. Because the outbreak of an epidemic like Corona has impacts on the composition and the quantity of solid wastes in a way that these changes have been studied in different studies [18, 19]. Also, in the time of Corona, the composition and the quantity of household and health-care wastes change and fluctuate owing to the changes in the lifestyle and the growing need of the community to medical services and the usage of self-protection commodities [20]. However, failing to re-evaluate the behaviour in waste management, as observed in the examined cities in this study, can have negative consequences in terms of health and environment. For example, the remarkable increase of non-recyclable wastes during the epidemic of Coronavirus is one of the environmental consequences [21]. Also, disposable polymeric material is an important source of plastic and microplastic contamination in the environment [22]. Furthermore, disposable face masks are made of polymer materials such as polypropylene, polyurethane, polyacrylonitrile, polystyrene, polycarbonate, polyethylene, and polyester; it is worth noting that littering face masks as a waste into the nature after consumption can be an important source for microplastic after decomposition [22]. Meanwhile, there is evidence of littering waste in urban areas and beaches [22] which requires planning for installation of specialized waste disposal containers for the equipment, as well as their regulated collection. Whereas, in

the studied cities no new containers for this equipment were installed and urban clean-up programs and the collection of littered wastes using the responsible organizations did not change purposefully compared to the pre-epidemic period.

On the other hand, inefficient solid waste management can lead to raising the epidemic of the Coronavirus [23]; a reason may be because of the fact that waste management personnel are not equipped with safety equipment in confronting suspected municipal wastes. Although the chance of the Coronavirus survival at temperatures above 20 °C is very low, the high probability of the presence of this virus in some types of waste has been reported; of course, the appropriate effect of disinfection methods on this virus has also been mentioned [2]. Accordingly, the management of PPE such as face masks is very important to prevent indirect infection of COVID-19 [10].

In addition to quantitative changes and the combination of municipal wastes, reports show that the production of health-care wastes during the epidemic of Corona has had a noticeable growth [24]. In South Korea, on the first days of February until the first days of March 2020, around 300 tons of health-care wastes were produced in public hospitals, temporary isolation facilities for overseas groups of South Koreans, isolated life treatment centers for patients with COVID-19, and community treatment centers, which reached 20 tons per day in April 2020 [10]. Variation in the quantity of the medical and dangerous waste in epidemic conditions such as the Coronavirus can impose shock on the solid waste management system in a way that an increase in the health-care wastes from a maximum of 40 tons per day was reported to be multiplied to 240 tons per day during the Corona epidemic in Wuhan, China, while the capacity of the incinerators of the city was 49 tons per day [8]. The results showed that, in Iran, the amount of health-care waste production increased during the COVID-19 epidemic. However, because of the lack of a rise in waste incinerator capacity, health-care wastes landfilled in layers of lime. Therefore, it is essential that health-care waste management be improved according to the changes. In several studies, the management of health-care wastes during the epidemic of COVID-19 has been taken into account [1, 25]; disinfection of these wastes using chemical and physical methods has been proposed [3]. Yu has proposed that the installation of temporary incinerators can be a solution for managing the produced mass health-care wastes during the Coronavirus period but it must be noted that choosing the suitable location for these temporary incinerators are also an important factor [11].

Generally, there is an important point to consider in management of disaster waste; as the results of the study by Kalina asserts that this issue must be inclusive of possible options for reuse or recycling, the modelling of potential impacts, systems reliability, and the restoration of post-disaster waste management systems [6]. Although health-care waste management during the epidemic is calculable, experiences rising from the COVID-19 showed that the use of disposable items such as masks in public as well as resting patients at homes [8] causes the proportion of solids with a risk of infection in the composition of municipal waste to increase, which requires an appropriate management. For instance, a suggestion for this situation is using a separate collecting system for households with positive or suspected COVID-19 cases. Also, at homes where there is a person with or suspected of Corona virus, it has been suggested that wastes should not be separated and they should be stored in a two-layered bag and with special storage conditions; then, they must be transported, and finally incinerated [9]. Therefore, changes in solid waste management during the epidemic, especially in health-care waste management and personal protective equipment with potential for contamination such as masks and gloves are necessary. For example, changes done in the health-care waste management in South Korea during the COVID-19 epidemic can be mentioned through which the amount of waste previously stored by 7 days was rejected and now it is managed based on a daily plan. Also, in this country, the 2-days temporary storage level is not exerted anymore during the COVID-19 period and the wastes are transported and incinerated on daily basis [10]. Rhee stated that, in South Korea, protection equipment like used masks are incinerated in the end, while such equipment that can be found in household wastes can be incinerated or landfilled. Regardless, transporting these wastes within either way must be via specified vehicles and at 4 °C [10].

Considering that three types of gloves: latex, nitrile, and vinyl can prevent transmission of the virus to the hands, using face masks, gloves, and other self-protection equipment is one of the main guidelines suggested by the WHO for the protection of the healthcare section personnel against COVID-19 [26]. On one hand, this condition has caused such equipment to be major constituents of the produced health-care wastes during the epidemic of Corona. On the other hand, concerns regarding an increase in using self-protection equipment such as N95 masks that leads to their shortage, and also the considerable growth of produced infected wastes has led to the idea of their decontamination and safe reuse to be proposed. Accordingly, a multiple level approach as a trustworthy way has been presented in a study for collection, storing, hydrogen peroxide vapor decontamination of the N95 masks [27]. In another experiment, it was found that the use of water vapor can also cause decontamination of facial masks and N95 masks, while this method does not lead to a significant reduction of the blocking efficiency of the mask [28]. As a result, this method for mask decontamination and its safe reuse have

been introduced as a suitable strategy to reduce the production of infectious waste during the epidemic [28]. Although in this study the status of municipal solid waste management during the pandemic and its changes towards before the pandemic were investigated, this study suffers from a few limitations that can be taken into account in future studies. For instance, the current research can be performed in rural and poor areas. Moreover, the status of municipal solid waste management can be studies in developed nations. Besides, possible changes in some of municipal solid wastes such as medical wastes and littered wastes can be studied individually.

Conclusion

The situation of municipal solid waste management in two cities of Iran before and during the epidemic of COVID-19 was compared. The results showed that, despite a change in the lifestyle and the composition of the municipal solid waste during the epidemic of COVID-19, there was no significant change in the municipal solid waste management. However, the waste management system for personnel protection had made improvements according to the health protocols. Due to the presented guidelines in all the sections of solid waste managements for the period of the Corona epidemic, it is necessary for the waste management system to comply with its guidelines. It seems that the shortage of a national protocol in Iran for municipal waste management during the epidemic of epidemics, specifically in the current situation, and disregarding the offered protocols from other organizations and countries are the main reasons for the lack of a proper response to changes in municipal solid waste composition and new safety and health requirements of waste management.

Acknowledgments The authors gratefully acknowledge the financial support given by Iran University of Medical Sciences, Tehran, Iran.

References

1. Peng J, Wu X, Wang R, Li C, Zhang Q, Wei D. Medical waste management practice during the 2019-2020 novel coronavirus pandemic: experience in a general hospital. Am J Infect Control. 2020;48:918, 921.
2. Carraturo F, Del Giudice C, Morelli M, Cerullo V, Libralato G, Galdiero E, Guida M (2020) Persistence of SARS-CoV-2 in the environment and COVID-19 transmission risk from environmental matrices and surfaces. Environ Pollut:115010.
3. Wang J, Shen J, Ye D, Yan X, Zhang Y, Yang W, Li X, Wang J, Zhang L, Pan L (2020) Disinfection technology of hospital wastes and wastewater: suggestions for disinfection strategy during coronavirus disease 2019 (COVID-19) pandemic in China. Environ Pollut:114665.
4. Official daily counts of COVID-19 cases and deaths worldwide. WHO Coronavirus Disease (COVID-19) Dashboard. Available in https://covid19.who.int. Accessed 2 Nov 2020.
5. Official daily counts of COVID-19 cases and deaths in Iran. Available in https://behdasht.gov.ir/. Accessed 2 Nov 2020.
6. Kalina M, Tilley E. "This is our next problem": cleaning up from the covid-19 response. Waste Manag. 2020;108:205–2.
7. Zambrano-Monserrate MA, Ruano MA, Sanchez-Alcalde L. Indirect effects of COVID-19 on the environment. Sci Total Environ. 2020;728:138813.
8. Klemeš JJ, Van Fan Y, Tan RR, Jiang P. Minimising the present and future plastic waste, energy and environmental footprints related to COVID-19. Renew Sust Energ Rev. 2020;127:109883.
9. Di Maria F, Beccaloni E, Bonadonna L, Cini C, Confalonieri E, La Rosa G, et al. Minimization of spreading of SARS-CoV-2 via household waste produced by subjects affected by COVID-19 or in quarantine. Sci Total Environ. 2020;743:140803.
10. Rhee S-W (2020) Management of used personal protective equipment and wastes related to COVID- 19 in South Korea. Waste Management & Research:0734242X20933343.
11. Yu H, Sun X, Solvang WD, Zhao X. Reverse logistics network design for effective management of medical waste in epidemic outbreaks: insights from the coronavirus disease 2019 (COVID-19) outbreak in Wuhan (China). Int J Environ Res Public Health. 2020;17(5):1770.
12. Waste Management During Covid-19 - ISWA's recommendations. International Solid Waste Association. Available in https://www.iswa.org. Accessed 1 Apr 2020.
13. COVID-19 and waste management activities. Waste Industry Safety and Health Forum, Information document. https://wishforum.org.uk. Accessed 2 Nov 2020.
14. What waste collectors and recyclers need to know about COVID-19. https://www.cdc.gov/coronavirus. Accessed 7 May 2020.
15. Information and statistics of trade. Ministry of Industry, Mine & Trade, Iran. https://www.mimt.gov.ir/. Accessed 7 May 2020.
16. Iranian national guidelines forwaste management during covid-19. Available in http://eoh.behdashtcdn.ir/170.pdf. Accessed 7 May 2020.
17. Mol MPG, Caldas S. Can the human coronavirus epidemic also spread through solid waste? Waste Manag Res. 2020;38(5):485–6.
18. Jribi S, Ben Ismail H, Doggui D, Debbabi H. COVID-19 virus outbreak lockdown: what impacts on household food wastage? Environ Dev Sustain. 2020;22:3939–55.
19. Aldaco R, Hoehn D, Laso J, Margallo M, Ruiz-Salmón J, Cristobal J, et al. Food waste management during the COVID-19 outbreak: a holistic climate, economic and nutritional approach. Sci Total Environ. 2020;742:140524.
20. Dente S, Hashimoto S. COVID-19: a pandemic with positive and negative outcomes on resource and waste flows and stocks. Resour Conserv Recycl. 2020;161:104979.
21. Cheval S, Mihai Adamescu C, Georgiadis T, Herrnegger M, Piticar A, Legates DR. Observed and potential impacts of the COVID-19 pandemic on the environment. Int J Environ Res Public Health. 2020;17(11):4140.
22. Fadare OO, Okoffo ED. Covid-19 face masks: a potential source of microplastic fibers in the environment. Sci Total Environ. 2020;737:140279.
23. Nzediegwu C, Chang SX. Improper solid waste management increases potential for COVID- 19 spread in developing countries. Resour Conserv Recycl. 2020;161:104947.
24. Saadat S, Rawtani D, Hussain CM (2020) Environmental perspective of COVID-19. Science of the Total environment:138870.
25. Powell-Jackson T, King JJ, Makungu C, Spieker N, Woodd S, Risha P, et al. Infection prevention and control compliance in Tanzanian outpatient facilities: a cross-sectional study with

implications for the control of COVID-19. Lancet Glob Health. 2020;8(6):e780–9.
26. Assadi M, Gholamrezanezhad A, Jokar N, Keshavarz M, Picchio M, Seregni E, Bombardieri E, Chiti A (2020) Key elements of preparedness for pandemic coronavirus disease 2019 (COVID-19) in nuclear medicine units. Eur J Nuclear Med Molec Imag 47.
27. Perkins DJ, Villescas S, Wu TH, Muller T, Bradfute S, Hurwitz I, Cheng Q, Wilcox H, Weiss M, Bartlett C (2020) COVID-19 global pandemic planning: decontamination and reuse processes for N95 respirators. Exp Biol Med:1535370220925768.
28. Ma QX, Shan H, Zhang CM, Zhang HL, Li GM, Yang RM, et al. Decontamination of face masks with steam for mask reuse in fighting the pandemic COVID- 19: experimental supports. J Med Virol. 2020;92:1974–1.